

**KENTUCKY DIVISION OF WATER
GENERAL DESIGN CRITERIA
FOR
SURFACE AND GROUND WATER SUPPLIES**

NOTES:

1. Design shall meet all applicable codes, including local, Kentucky and Federal regulations.
2. References include Recommended Standards for Water Works – 2007 Edition (Ten States Standards). In some instances, the criteria presented here are different than Ten States Standards criteria. In most instances, criteria in this document are presented to emphasize certain items in Ten States Standards. Where the design criteria in this document differ from Ten States Standards, this document shall govern. In all instances, regulatory requirements shall govern.
3. Special consideration of operating personnel expertise should always be an integral consideration during design.
4. Variation from the design criteria will be considered on a case-by-case basis.

**WATER TREATMENT PLANT RATED DESIGN CAPACITY AND PROCESS
REDUNDANCY**

The water treatment plant rated design capacity is the maximum rate for water treatment plant operation as approved by the Cabinet's Division of Water. The rated design capacity shall be calculated with redundant processes and excess capacities out of service as described in this document. The rated design capacity shall be expressed in Million Gallons per Day (MGD) and gallons per minute (gpm) and shall be based on a 24-hour period of operation.

Redundant treatment components should be equally sized to facilitate ease of operation.

**SURFACE WATER SUPPLIES OR GROUND WATER SUPPLIES UNDER
INFLUENCE OF SURFACE WATER**

1. **Raw Water Source** – Written approval from the Watershed Management Branch must be obtained for use of the proposed raw water source/s to supply the rated design capacity of the proposed water treatment plant.
2. **Raw Water Intake**
 - a. Multilevel withdrawal is required where water quality varies with depth unless the design engineer can show the ability to take raw water from more than one level is not beneficial.

- b. Removable or traveling screen is required.
- c. Entrance velocity ≤ 0.5 fps recommended.
- d. Back flush cleaning is recommended.
- e. Adequate provisions for addition of pretreatment chemicals as may become necessary are required.
- f. Adequate provision for maintenance of equipment and facility is required.

3. Raw Water Pumping Facilities

- a. A minimum of 2 pumps is required, and 100% of the water treatment plant rated design capacity shall be supplied with largest pump out of service.
- b. Security fence recommended.
- c. Protection of electrical equipment and accessibility required sufficient to offset impacts of a 100 year flood event.
- d. Surge control shall be provided for normal pump starting and stopping.

4. Treatment Processes

- a. Rapid mix:
 - (1) Detention time <30 seconds recommended (in no case >60 sec).
 - (2) Backup capacity of 100% of the water treatment plant rated design capacity is recommended. A separate, additional rapid mix is required for separate, significantly different treatment processes.
 - (3) Variable speed drive recommended if plant flow rate varies significantly.
- b. Flocculation:
 - (1) Minimum of 2 basins/trains required.
 - (2) Detention time = 30 minutes minimum.
 - (3) Tapered (2 or 3 compartments) w/variable speed drive mixers is required.
 - (4) Flow thru velocity of 0.5 to 1.5 fpm.
 - (5) Exit velocity of 0.5 fps to 1.5 fps.
 - (6) At least 2 units are required, and at least 50% of the water treatment plant rated design capacity requirements shall be met with one basin out of service.

- c. Sedimentation:
 - (1) Minimum of 2 basins/trains required.
 - (2) Detention time ≥ 4 hours without tube or plate settlers.
 - (3) Detention time ≥ 2 hours with tube settlers recommended.
 - (4) Tube settlers ≤ 2.0 gpm/ft² surface overflow rate.
 - (5) Plate settlers ≤ 0.5 gpm/ft² surface overflow rate based on 80% of projected horizontal plate area. A surface overflow rate of 0.3-0.35 gpm/ft² recommended.
 - (6) Length to width ratio $\geq 3:1$ recommended for basins without tube or plate settlers.
 - (7) Sludge collection and removal equipment required.
 - (8) At least 2 units are required, and at least 50% of the water treatment plant rated design capacity requirements shall be met with one basin out of service.
- d. Solids contact clarifier (up-flow clarifier):
 - (1) Minimum of 2 basins required.
 - (2) Surface overflow rate ≤ 1.25 gpm/ft² with raw water turbidity ≤ 30 NTU's year around.
 - (3) Surface overflow rate ≤ 0.75 gpm/ft² with raw water turbidity > 30 NTUs at any time during year.
 - (4) At least 2 units are required, and at least 50% of the water treatment plant rated design capacity requirements shall be met with one basin out of service.
 - (5) Sludge collection and removal equipment required.
- e. Ballasted flocculation:
 - (1) Approval requires demonstrating satisfactory performance with on site pilot plant testing under all operating conditions or documentation of full plant scale plant operation with similar parameters such as raw water quality, pretreatment & any other significant parameters determined necessary to demonstrate applicability to the proposed treatment. Piloting protocol shall be submitted to the DOW for approval.
 - (2) At least 2 units are required, and at least 50 % of the water treatment plant rated design capacity requirements shall be met with one unit out of service.
 - (3) Pilot testing of combined clarifier & filtration processes required if not used with conventional gravity, granular media filters.
- f. Dissolved air flotation:
 - (1) Design shall include manufacturer's recommendations.

- (2) Approval requires demonstrating satisfactory performance with on site pilot plant testing under all operating conditions or documentation of full plant scale plant operation with similar parameters such as raw water quality, pretreatment & any other significant parameters determined necessary to demonstrate applicability to the proposed treatment. Piloting protocol shall be submitted to DOW for approval.
 - (3) At least 2 units are required, and at least 50 % of the water treatment plant rated design capacity requirements shall be met with one unit out of service.
- g. Filters (granular media):
- (1) Gravity filtration is required. Pressure filtration is not allowed for the treatment of surface water supplies.
 - (2) Filter rate ≤ 2 gpm/ft.² (sand/single media).
 ≤ 5 gpm/ft² (multi-media).
 - (3) A minimum of 2 filters are required, and 100% of the water treatment plant rated design capacity shall be met with one filter out of service.
 - (4) Backwash rate: 15 gpm/ft² minimum to 20 gpm/ft² recommended (as necessary to provide 50% expansion of filter bed).
 - (5) There shall be no air delivery piping passing through the media or any other arrangement in the filter design which would allow short circuiting of the applied water.
- h. Filters (membrane):
- (1) Approval requires demonstrating satisfactory performance with on site pilot plant testing under all operating conditions or documentation of full plant scale plant operation with similar parameters such as raw water quality, pretreatment & any other significant parameters determined necessary to demonstrate applicability to the proposed treatment. Piloting protocol shall be submitted to DOW for approval
 - (2) Pretreatment – Follow criteria for rapid mixing, flocculation and sedimentation requirements above if using conventional pretreatment. If direct application of flocculated water is used, maximum detention time shall be as recommended by the membrane manufacturer to provide pin floc. This detention time is usually 5 to 15 minutes maximum. In all cases, pretreatment shall provide for oxidation of minerals such as iron and manganese.
 - (3) Flux rate – maximum determined by pilot testing or other data from similar full-scale operations.

- (4) Minimum 20% excess membrane capacity over the water treatment plant rated design capacity.
 - (5) Integrity testing = minimum of once per day.
 - (6) Maintenance clean system required.
 - (7) Recovery clean system required.
 - (8) Shall meet the water treatment plant rated design capacity with one train out of service.
 - (9) Redundancy of critical control components required.
- i. Clear Well
 - (1) Required volume \geq 15 percent of the water treatment plant rated design capacity. Less than 15% may be approved if it can be shown that a lesser volume will be adequate in terms of required CT value, adequate backwash source water and other relevant considerations.
 - (2) Two separate compartments or two separate clear wells required with continued access to high service pumping to allow maintenance to one chamber or one clear well without interrupting service.
- j. High Service Pumps
 - (1) A minimum of 2 pumps is required, and 100% of the water treatment plant rated design capacity shall be supplied with largest pump out of service.
 - (2) Surge control shall be provided for normal pump starting and stopping.
- k. Chemical Feed Systems:
 - (1) Chlorination is required.
 - (2) Fluoridation as required by 902 KAR 115:010.
 - (3) The ability to feed carbon is required.
 - (4) Other chemicals shall be required and used as determined necessary by the treatment process and raw water quality.
- l. Disinfection
 - (1) The disinfection treatment must be sufficient to ensure that the total treatment processes of that system achieve at least 99.9 percent (3-log) inactivation and/or removal of *Giardia lamblia* cysts and at least 99.99 percent (4-log) inactivation and/or removal of viruses.
- m. UV – Disinfection
 - (1) UV should be installed downstream of filtration.
 - (2) Hydraulics should be designed to allow all elements of fluid to come sufficiently close to the lamp surface.

- (3) UV unit should be installed with adequate upstream and downstream distances from any flow disturbances.
 - (4) Effective cleaning methodology shall be in place to periodically remove biological and chemical fouling materials from lamp jacket or tube surfaces.
 - (5) UV intensity sensors, transmittance monitors, and water temperature sensors should be considered.
 - (6) Flow meters shall be installed to allow accurate measurement of the flow rate to each reactor.
 - (7) Recirculation loops or flow-to-waste capability for UV reactors that require cooling water during lamp warm-up should be considered.
 - (8) Vents and/or air release, air/vacuum, or combination air valves to discharge any introduced air and to facilitate reactor draining are required.
 - (9) Hydraulic design should allow reactors to stay flooded under all operating conditions.
 - (10) Appropriate materials of construction should be used for piping materials exposed to UV light and for all components within the building environment.
- n. Standby Electric Power
- (1) Dedicated standby or alternate electric power source is required so that water may be treated and/or pumped to the distribution system during power outages to meet the average day demand.
- o. Security System:
- (1) Door and window locks are required.
 - (2) Security fencing recommended.
 - (3) Security monitoring system recommended.

Note: Items "g" through "j" and "m" through "o" are also applicable to ground water systems not under the influence of surface water.

GROUND WATER SUPPLIES NOT UNDER THE INFLUENCE OF SURFACE WATER

1. Raw Water Source

- a. A minimum of two wells shall be provided and 100% of the water treatment plant rated design capacity shall be supplied with the largest well out of service.
- b. Well location and design shall be reviewed and approved by DOW before construction.

- c. Well head and groundwater protection plan required.

2. Treatment

- a. Chlorination is required.
- b. Fluoridation as required by 902 KAR 115:010.
- c. Additional treatment shall be required if necessary to provide acceptable finished water quality, including 4-log virus removal/inactivation.

WATER DISTRIBUTION SYSTEM

1. Pressure

- a. Minimum system pressure for all conditions shall be 20 psi.
- b. Water lines should be hydraulically capable of a flow velocity of 2.5 ft/s while maintaining a pressure of at least 20 psi.
- c. If the maximum pressure exceeds 100 psi at the service connection it is recommended the customer and utility be notified of the potential need for a pressure reducing valve.
- d. The normal working pressure in the distribution system should be approximately 60-80 psi and shall not be less than 30 psi under peak demand flow conditions. Peak demand is defined as the maximum customer water usage rate, expressed in gallons per minute (gpm), in the pressure zone of interest during a 24 hour (diurnal) time period.

2. Pipe Diameter

- a. Mains serving fire hydrants shall be minimum 6-inch diameter.
- b. Mains without hydrants shall be minimum 3-inch diameter. Any departure from minimum requirements shall be justified by hydraulic analysis and future water use, and can be considered only in special circumstances.

3. Flushing

- a. Flushing valves and hydrants should be sized, installed and configured, to provide flows which will give a velocity of at least 2.5 feet per second in the water mains being flushed.

4. Pipe Location

- a. Pipe shall be constructed to a depth providing a minimum cover of 30 inches to top of pipe.
- b. Water pipe shall be constructed with a lateral separation of 10 feet or more from any sewer measured edge to edge where practical. If not practical,

the water pipe may be installed closer to the sewer provided the water pipe is laid in a separate trench or undisturbed shelf located on one side of the sewer with the bottom of the pipe at least 18 inches above the top of the sewer pipe.

- c. For water lines crossing sewer lines, the top of the water pipe shall be a vertical distance of at least 18 inches below the bottom of the sewer pipe or the bottom of the water pipe shall be a vertical distance of at least 18 inches above the top of the sewer pipe.
- d. A plan for a water line that would propose a section of line be laid within a 200 foot radius of an underground storage tank as defined in KRS 224.60-100 or a petroleum storage tank as defined in KRS 224.60-115, shall provide that all water lines within the 200 foot radius shall be ductile iron pipe or other nonpermeable pipe approved by the cabinet. Any future replacement of an existing water line within a 200 foot radius of a storage tank, whether or not plans are submitted to the cabinet, shall also meet this requirement. The requirements of this subparagraph may be waived, in writing, if the public water system shows to the satisfaction of the cabinet, that the protection afforded by nonpermeable material is unnecessary due to hydrological, geological, or other physical conditions at a particular site.

5. Air Relief Valves

- a. Shall be located at high points to remove air.

6. Distribution Storage

- a. Water storage tanks must have a minimum 100% turnover rate of once per 72 hours.
- b. Minimum water level for all gravity storage tanks shall maintain a minimum design pressure of 30 psi for all potential points of use supplied by the tank.
- c. Separate inlet and outlet is required on storage tanks; and the inlet has to be in the upper half of the tank (unless there is a separate mixing system).